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54. Insufflation gas conditioning device

The invention relates to an insufflation gas conditioning device with means for adjusting the moisture content and/or the temperature of the gas to those required in a human body, for use for an insufflation system that has a compressed gas reservoir, which is connected on its output side with the beginning of a gas supply line (90) which is preferably realized in the form of a hose and is connected to the insufflation instrument (100). The means to adjust the moisture content and/or the temperature of the gas to be adjusted and/or means (6) to reduce the level of foreign matter in the gas are located on one of the ends of the gas supply line (90) provided between the insufflation system and the insufflation instrument (1), whereby the means (3) to adjust the gas temperature are located on the end of the gas supply line (90) past which the gas flows last during the delivery.

Description

This invention relates to an insufflation gas conditioning device of the type described in the introduction to Claim 1.

During minimally invasive interventions in human or animal bodies, for example in the area of the abdomen (in laparoscopic surgery), the uterus (in hysteroscopy) or in joints (in arthroscopic surgery), it is necessary to expand a cavity located there by means of a gas, whereby preference is given to the use of carbon dioxide. The space thereby created represents a sufficiently large area for surgery or examination and makes it possible for the operator to perform the necessary medical interventions via suitable access points into the body cavity.

The development of laparoscopic surgery, which utilizes the advantages of minimally invasive techniques, has led to increased gas flows. During an operation, however, these high gas flows lead to undesirable increased stress on the patient as a result of the extraction of heat and moisture from the body tissues in the area of the intervention.

The order of magnitude of the extraction of heat can be illustrated by the fact that the insufflated, relatively cool gas at a gas flow of 30 liters per minute and a temperature increase of 20 °C absorbs a quantity of heat that would require an electrical power of approximately 16 Watts to génerate. That equals approximately 20 per cent of the total quantity of heat that the human body generates in narcosis.

The drying of the body cavity that has been expanded by gas insufflation is caused by the fact that the gas extracted from a compressed gas reservoir for a gas insufflation contains essentially no moisture. In connection with the heating of the gas caused by the available body heat, the insufflated gas has a particularly high capacity to absorb moisture and extracts moisture to a greater extent from the insufflated body cavity, organs or vessels, whereby at the same time the cooling of the body cavity is increased.

The more gas that is insufflated, in particular during a relatively short period, the greater the disruptive effects on the organism.

To prevent damage to the insufflated area of the body, for example by a catarrhal effect in the event of lung surgery, it is necessary in many cases to connect a gas insufflation with a gas conditioning system. The gas is thereby heated in the insufflation device or in an accessory device to the temperature of the patient's body, and can also be humidified if necessary.

European Patent Application EP 0 564 953 A1 describes a heating device for the insufflation unit, by means of which a gas at a greatly reduced pressure which has a temperature at the discharge from the unit in the range of 18°C to 24°C, is heated to 30°C to 35°C to heat it to the temperature of the human body. The heating device consists essentially of a heater hose that creates the connection between the insufflation device and an insufflation instrument for the introduction of the gas, preferably carbon dioxide, into the body. The heating hose has an outer and inner hose layer that are both made of plastic, with a heating coil placed between them. The length of the hose is in the range of 1.8 to 2.5 m.

However, the solution described above has the disadvantage that the gas supply line has a greatly enlarged diameter and is very stiff on account of its internal heating coil, which means that the insufflation instrument becomes significantly more difficult to handle. This solution is also disadvantageous from the point of view of the efficient use of energy, because heat losses along the length of the gas supply line, which is up to 2.5 m long, cannot be avoided. If relatively small amounts of gas are insufflated, the flow velocity along the walls of the hose is very low, which means that the amount of heat that must be transferred to the gas via the wall of the hose is impossible or at least very difficult to achieve. The constructive modification of the gas supply line also has the disadvantage that it requires a separate coupling part to be able to connect the insufflation instrument to the gas supply line.

European Patent Application EP 0 569 241 A2 and US Patent US 5 006 109 also describe insufflation systems in which the gas is heated inside the actual gas supply system even before it is set to the desired pressure. The addition of moisture to the gas, if such a capability is provided, is performed separately from the gas heating outside the gas supply system.

This form of gas conditioning is therefore disadvantageous, because if the gas it heated inside the gas supply system, it is necessary to protect heat-sensitive control and instrumentation equipment with special thermal insulation. A large amount of heat must also be added to the insufflation gas, to provide compensation for the heat that is lost along the transport route to the point where the gas is introduced into the body. A smaller amount of added heat and thus a more energy-efficient form of gas conditioning is possible in this case by increasing the thermal insulation of the gas supply line. But that in turn results in a disadvantageous increase in the diameter of this line, as a result of which the overall manufacturing costs for the gas feed line are increased. On account of the larger-diameter gas feed line, the insufflation instrument also becomes significantly more difficult to handle.

The object of the invention is therefore to create an insufflation gas conditioning device of the type described above which both has a simpler construction and is more energy-efficient than similar devices of the prior art, and in which the insufflation instrument is simultaneously easier to operate.

The invention teaches that this object is accomplished by the features disclosed in the characterizing portion of Claim 1.

The invention teaches that there are advantages in terms of construction and energy-efficiency to the use of a conditioning device in which a gas to be insufflated is conditioned so that it meets the requirements of the specific intervention or the specific patient, in which advantages in terms of the construction and energy-efficiency of the

insufflation system can be achieved if at least the means of the conditioning device with which the temperature of the gas to be insufflated is adjusted are positioned as close as possible to the location in which the insufflated gas is to be used.

The term “conditioning” as used in this document means the heating and/or humidification and/or filtration and in particular a combination of at least two of these treatments of the insufflation gas.

In the conditioning device, there are means in one preferred embodiment of the invention with which the temperature and the moisture content of the gas or the content of foreign matter in the gas can optionally be adjusted to the specific application of the gas. It is thereby advantageous that means to adjust the required moisture content of the gas are located on the discharge side of a heat exchanger provided in the conditioning device to adjust the temperature of the gas, because on one hand, the gas, because it has already been heated, promotes the absorption of moisture and on the other hand makes it possible to compensate for the latent heat that accompanies the loss of moisture.

The conditioning device has connection means both on the inflow side and on the discharge side that create a connection with the gas supply line and with the insufflation instrument. To connect the conditioning device with the gas supply line, a hose nipple is advantageous in each case. For the connection of the conditioning device with the insufflation instrument, connecting means in the form of a plug-in piece, preferably one that has a conical shape, or a threaded connector are advantageous, because such connections result in particularly short transition distances between the conditioning device and the insufflation instrument, and the conditioning device and the insufflation instrument can be easily combined into a single unit.

Because the transfer of heat to the gas that is to be insufflated and is already at the desired pressure takes place only in the immediate vicinity of the area where the gas is to be used, it is advantageous that no constructively complex measures are required to

prevent thermal losses or the effects of subsequent changes in pressure on the temperature of the gas.

A potential thermal loss in the vicinity of the insufflation instrument can be considered negligible, because the greater part of the instrument is inside the patient's body or in the surgeon's hand, and the temperature differential between the gas to be insufflated and the temperature of the insufflation instrument is nearly zero.

The shape of the gas supply line is essential for the ease of handling of the overall insufflation system. That is because, when the gas is heated by the conditioning device that is connected directly with the insufflation instrument, which makes potential thermal losses insignificant, the gas supply line is very lightweight and flexible, the insufflation instrument is extraordinarily easy to handle.

In an additional exemplary embodiment of the invention, the connecting means can be connected with each other, preferably by means of a threaded connection, to form a closed ring-shaped space. This ring-shaped space forms a part of a heat exchanger, the heating element of which can be realized for example in the form of a heating film or in the form of a heating coil and can surround the ring-shaped space in the form of a sleeve. The transfer of heat into the gas to be conditioned, which is slowed down by baffles in one of the connection means and is forced to flow through the ring-shaped chamber, is advantageously achieved by thermal conduction.

In one advantageous development of the invention, the heat exchanger that is used to increase the temperature of the gas to be insufflated is realized in an essentially cylindrical shape. It consists of a ceramic body made of a material that has good thermal conductivity with cylindrical passages that extend in the flow direction of the gas. To heat the ceramic body it is possible to provide an electrical heating line and at least one temperature sensor for the regulation of the temperature of the gas.

In an additional advantageous realization of the heat exchanger, heatable surface elements are provided for the thermal transfer which are flowed over by the gas to be insufflated, and which are realized in the shape of stars or curves, or are arranged inside the heat exchanger to form baffles that extend essentially at right angles to the direction of the flow.

The means to change the moisture content of the gas that are located downstream of the heat exchanger in the direction of flow of the gas are hydrophilic, are preferably realized in the form of a sponge and are fastened to the surface of the cylindrical heat exchange body in the form of a coating. The required quantity of water can be extracted from a fluid reservoir by means of a capillary. The fluid reservoir is located on the outside wall of the conditioning device.

In one advantageous development of the invention, the fluid reservoir has a connecting line to the inflow side of the heat exchanger, to assist the transport of water into the sponge-like body (which otherwise occurs essentially only by capillary action) with additional pressure. In the conditioning device, a humidity sensor is provided on the outflow side of the heat exchanger, so that a combined regulation of the gas conditioning can be achieved in combination with the measurement of the gas temperature.

In an additional development of the invention, in which the means to adjust the temperature and the humidity of the gas to be insufflated are not in the same position, the means for humidification are realized in the form of an ultrasound nebulizer.

In an additional development of the invention, the means to reduce the content of foreign matter are combined with the means to adjust the humidity to form a single unit. This unit is located upstream of the moisture dispenser and contains filter elements that are made of paper or that have electrostatically charged plastic fibers.

Advantageous developments of the invention are described in the subclaims or are described in further detail below, together with the description of the preferred embodiment of the invention, with reference to the accompanying figures, in which:

Figure 1	is a longitudinal section through one preferred exemplary embodiment of the invention,
Figure 2	is a view of the inflow side of the heat exchanger of the conditioning device illustrated in Figure 1,
Figures 3a to 3c	show advantageous developments of the heat exchanger of the embodiment of the invention illustrated in Figure 1,
Figure 3d	shows an additional exemplary embodiment of the conditioning device claimed by the invention,
Figure 4	shows a longitudinal section through an additional advantageous exemplary embodiment of the invention,
Figures 5a to 5c	are longitudinal sections through the conditioning device illustrated in Figure 4, and
Figure 6	shows an additional development of the invention.

The conditioning device 1 illustrated in a schematic longitudinal section in Figure 1 is realized in the form of a cylindrical hollow body that can carry a flow and has, on its inflow side and on its outflow side, respective connecting means 11 and 12, which can be connected with the gas supply line 90 or with the insufflation instrument 100 of an insufflation system. The conditioning device 1 for the gas 16 to be insufflated thereby forms a direct coupling element between the gas supply line 90 and the insufflation instrument 100 and makes the use of additional elements superfluous. The connecting means 11 are preferably realized in the form of hose nipples, although the connecting means can also be realized in the form of a threaded connector or a preferably conical plug-in element, depending on the configuration of the insufflation instrument 100. The connecting means 101 present on the insufflation instrument 11 are selected to match the connecting means 12 of the conditioning device 1, so that the conditioning device 1 can be integrated at least partly into the construction of the insufflation instrument. The

conditioned insufflation gas 17 can thereby advantageously reach the site where it is to be used via the shortest route.

The heat exchanger 3 which is provided for the heating of the gas to be insufflated, preferably up to the patient's body temperature, is realized in the form of a cylindrical disk and is shown in Figure 2 in an overhead view from the inflow side. It has a plurality of identically realized, preferably cylindrical passages 10, the longitudinal axis of which runs parallel to the direction of flow of the gas 16, 17 and is made of a material that is a good thermal conductor, preferably of a ceramic material. On the outflow side of the heat exchanger 3 there are means 4 that are realized in the form of a sponge to increase the moisture content of the gas 16. The sponge coating 4 that is fastened to the outflow side of the heat exchanger 3 is supplied with water 7 from a fluid reservoir 6 by means of a capillary tube 9. To use the pressure on the inflow side of the heat exchanger 3 to support the discharge of the water, there is a connecting line 8 between the fluid reservoir 6 located on the outside of the conditioning device and the inflow side of the heat exchanger 3.

The heat is input into the heat exchanger 3 via heating wires 13 which are fastened to the heat exchanger 3 on the inflow side. The thermo-elements 14, 15 supply the measurements that are necessary to regulate the temperature. The corresponding connecting lines are designated 18.

Downstream of the capillary 9 there is a filter element 5 to remove particles of foreign matter from the heated and humidified gas 17 at the output of the heat exchanger 3.

Figures 3a, 3b and 3c are simplified illustrations of additional forms for the heat exchanger 50, 60 and 70 that can be used in the conditioning device. To achieve the most compact heat exchanger possible and simultaneously have a large heat exchange surface available, there are a plurality of heatable surface elements 51, 61, 71 respectively, which are located in the shape of a star or an arrow in a flat surface, or are

provided with curved surfaces that restrict the flow path of the gas to be conditioned in the radial direction.

In the conditioning device 80 shown in longitudinal section in Figure 3d, there is only a heating of the gas 82 to be insufflated. The heat exchanger is formed from a plurality of heatable obstacles 81 that extend essentially at right angles to the direction of flow, which come in contact with the gas 82 when the gas flows through the device 80.

Figure 4 illustrates an additional exemplary embodiment of a conditioning device 20 in longitudinal section. The individual parts 21, 22, 23 that make up the conditioning device 20 are also shown in longitudinal section in Figures 5a, 5b and 5c.

The individual parts 21 and 22 each have a hose nipple 30, 40 as connecting means. The ends of the connecting means farther from the respective hose nipples can be screwed together by means of the threaded portions 21.2 and 22.2 provided there, and thereby enclose a cylindrical annulus 27. A partition 21.5 that blocks the flow channel 21.1 of the hose nipples 30 on the discharge side forces the gas to be conditioned to flow via the borings 21.4 into the annulus 27 and via the borings 21.3 out of the annulus 27 into the flow channel 22.1 of the hose nipples 40. The flow of the gas to be conditioned is thereby slowed down and swirled without any significant increase in the flow resistance inside the conditioning device 20.

By means of the threaded segment 22.3 of the hose nipple 40, the hose nipples 30, 40 that are connected with each other can be connected by screwing with a sleeve-shaped heater body 23 (threaded segment 23.1) that is made of a material that is not a good conductor of heat, which - on account of the presence of a conical guide - is in close contact with the outside wall of the annulus 27, so that there can be a transfer of heat that is directed essentially radially inward into the gas to be insufflated by thermal conduction. For this purpose, the heating body 23 has on its inside wall an electrical heating element 23.2, which is realized in the form of a coil or film.

The heat exchanger realized in this manner is enclosed by a housing that can be composed of two parts 24, 25 and with axial passages, from which the hose nipples 30, 40 project. The diameter of one of the axial passages can be varied as a result of the use of a variable diaphragm 26.

The system of borings 21.3 and 21.4 in the individual parts 21 described above makes it advantageously possible to freely select the direction of flow of the gas to be insufflated in the conditioning device 20.

The insufflation system illustrated in Figure 6 has an insufflation unit 92 which supplies the gas to be insufflated at the appropriate pressure, a gas supply line 90, a conditioning device 1' and an insufflation instrument 100 which is connected on the outflow side by means of an adapter 102 to the conditioning device 1'. The conditioning device 1' is used to heat the gas to be insufflated. The electrical heat output is supplied by means of a line 91 from the insufflation unit 92. The connecting means 11, 12 of the conditioning device 1' are realized in the form of hose nipples. The use of the adapter 102 makes it advantageously possible to connect various insufflation instruments 100 to the conditioning device.

The realization of the invention is not limited to the preferred exemplary embodiment described above. Rather, a number of variants are conceivable that make use of the solution claimed by the invention in fundamentally different realizations.

In particular, conditioning devices that are of identical or similar construction can be operated by means of a control unit that is connected with the output of a sensor that is associated with the insufflation instrument or the body cavity to be insufflated, so that the parameters of the insufflation gas are controlled. The extensive physical integration of the heating and humidification devices also makes possible a simplified combined control or regulation of the temperature and humidity. The temperature sensors and/or humidity sensors and control components required for this purpose are themselves described in the prior art.

Claims

1. Insufflation conditioning device with means for the adjustment of the gas humidity and/or gas temperature to the conditions in a human body, to be used for an insufflation system (29) that has a compressed gas reservoir, which is connected on the output side with the beginning of a gas supply line (90) that is preferably realized in the form of a hose and is connected to an insufflation instrument (100), **characterized by** the arrangement of the means (3, 4, 20, 50, 60, 70, 80) that are suitable for the adjustment of the humidity and/or the temperature of the gas to be insufflated and/or means (5) to reduce the content of foreign matter to one of the ends of the gas supply line (90) provided for the connection between the insufflation system (92) and the insufflation instrument (100), whereby the means (3, 20, 50, 60, 70, 80) that adjust the gas temperature are located on the end of the gas supply line (90) that the gas flows past last during the delivery.

2. Conditioning device as claimed in Claim 1, characterized by the fact that the means (3, 4) are physically integrated to at least a partial extent with the insufflation instrument (100).

3. Conditioning device as claimed in one of the preceding claims, characterized by the fact that associated with the means (3, 4) to influence the humidity and/or the temperature of the gas are at least one means (5) by which the foreign matter content in the insufflation gas (16, 17) is reduced.

4. Conditioning device as claimed in Claim 1, characterized by the fact that the means to influence the temperature or humidity of the gas have, on the inflow and outflow side, respective connecting means (11, 12, 30, 40, 83, 84), whereby at least one of the connecting means is realized in the form of a hose nipple (30, 40).

5. Conditioning device as claimed in Claim 4, characterized by the fact that the outflow-side connecting means (12) are realized in the form of a threaded connection.

6. Conditioning means as claimed in Claim 4, characterized by the fact that the outflow-side connecting means (12) are realized in the form of plug-in connecting means.

7. Conditioning device as claimed in one of the preceding claims, characterized by the fact that an adapter (102) is provided between the outflow-side connecting means (12) and the insufflation instrument (100).

8. Conditioning device as claimed in Claim 3, characterized by the fact that the means to influence the temperature of the flow medium are realized in the form of a heat exchanger 93, 20, 50, 60, 70) which consists of an essentially cylindrical body that can carry a flow, and the axis of which runs essentially parallel to the direction of flow of the gas (16, 17) to be insufflated.

9. Conditioning device as claimed in Claim 8, characterized by the fact that as the heat exchanger, a ceramic disk (3) is provided which has passages (10) that are provided with inserted electrical heating elements (13).

10. Conditioning device as claimed in Claim 8, characterized by the fact that inside the heat exchanger (20) there are deflector means (21.3, 21.4, 21.5) to slow down or to swirl the gas.

11. Conditioning device as claimed in one of the Claims 10 and 11, characterized by the fact that the cylinder consists of two individual parts (21, 22), each of which has connecting means (30, 40) for the connection with the gas supply line and with the insufflation instrument, which individual parts are screwed together to form a cylindrical annulus (27), which is surrounded by a heating element (23) that has a heater film or a heater coil (23. 2).

12. Conditioning device as claimed in Claim 8, characterized by the fact that the heat exchanger (50, 60, 70, 80) has heatable surface elements which are realized in the shape of a star (51) or curves (61), forming obstacles (81) inside the heat exchanger that extend essentially at right angles to the direction of the flow.

13. Conditioning device as claimed in one of the Claims 8 to 12, characterized by the fact that the means (4) to influence the humidity of the gas (16, 17) to be insufflated are located on the outflow side of the heat exchanger (3, 50, 60, 70, 80).

14. Conditioning device as claimed in one of the Claims 8 to 13, characterized by the fact that means are realized in the form of a hydrophilic, preferably sponge-like element (4) and are fastened to the surface of the heat exchanger (3).

15. Conditioning device as claimed in Claim 14, characterized by the fact that the fluid reservoir (6) is located on the external wall of the conditioning device (1).

17. Conditioning device as claimed in Claim 15, characterized by the fact that the fluid reservoir (6) has a connecting line (8) to the inflow side of the conditioning device.

18. Conditioning device as claimed in Claim 1, characterized by the fact that the means to influence the moisture content of the gas to be insufflated are realized in the form of an ultrasound nebulizer.

19. Conditioning device as claimed in one of the Claims 8 to 15, characterized by the fact that a filter element (5) to reduce the content of solid matter in the insufflation gas is provided which is located on the outflow side of the heat exchanger (3).

20. Conditioning device as claimed in Claim 3, characterized by the fact that associated with the insufflation instrument or the body cavity to be insufflated is at least

one sensor to measure the temperature and/or the humidity of the gas, the output signal(s) of which is/are used to control the gas conditioning.

21. Conditioning device as claimed in Claim 20, characterized by the fact that the heat exchanger (3) has at least one thermo sensor (14, 15), the output signal of which is used to control the temperature of the insufflation gas.

22. Conditioning device as claimed in Claim 3, characterized by the fact that the means (5) to reduce the content of foreign matter are associated with the means (4) to adjust the humidity, and have filter elements made of paper or having electrostatically charged plastic fibers.

6 pages of drawings

Nummer: DE 195 10 710 A1
Int. Cl.⁶: A 61 B 19/00
Offenlegungstag: 19. September 1996

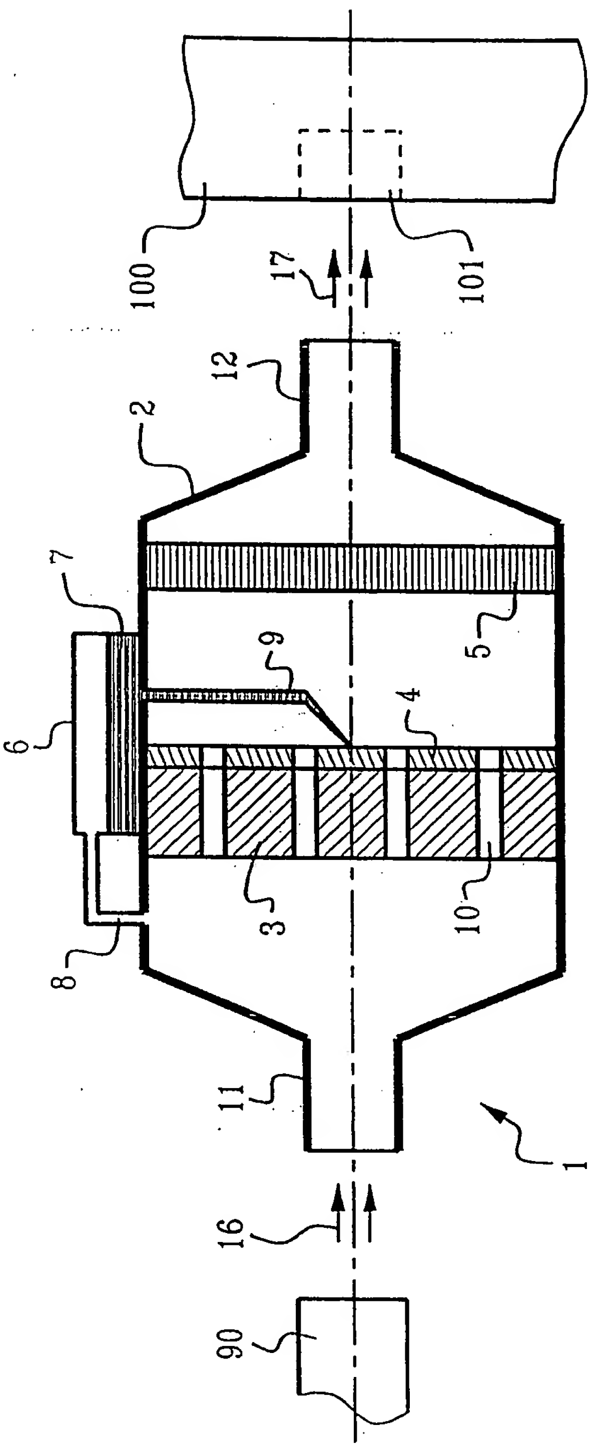

Fig. 1

Nummer: DE 195 10 710 A1
Int. Cl.6: A 61 B 19/00
Offenlegungstag: 19. September 1996

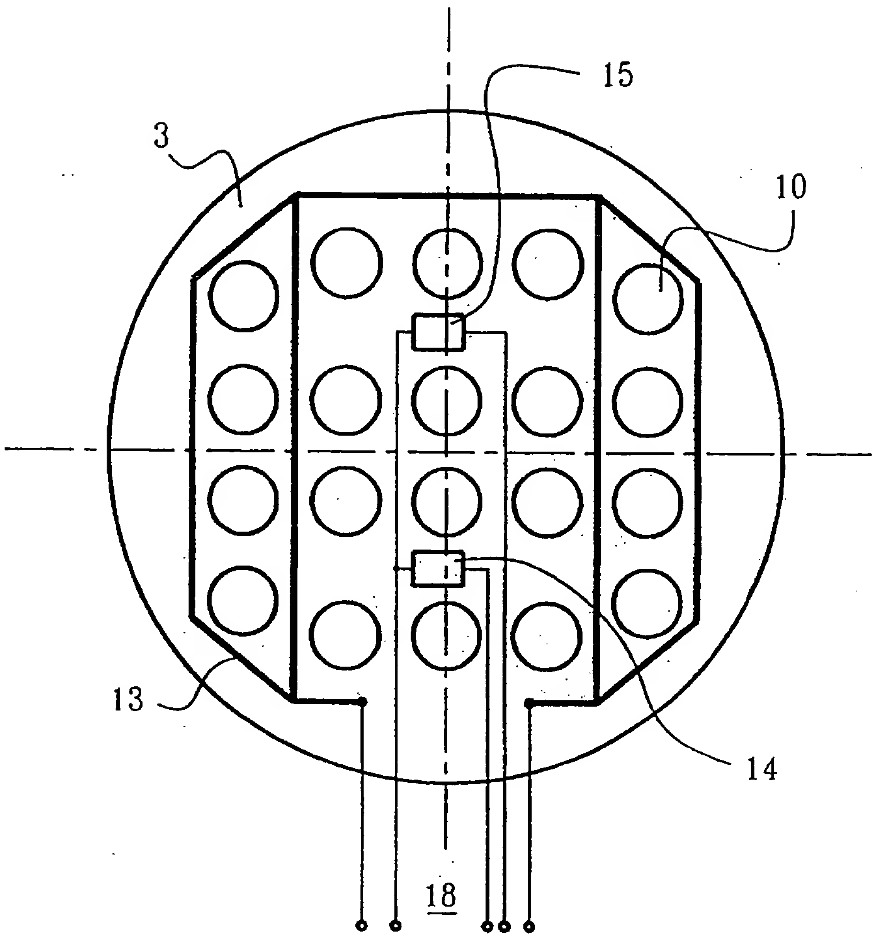

Fig. 2

Nummer: DE 195 10 710 A1
Int. Cl.[6]: A 61 B 19/00
Offenlegungstag: 19. September 1996

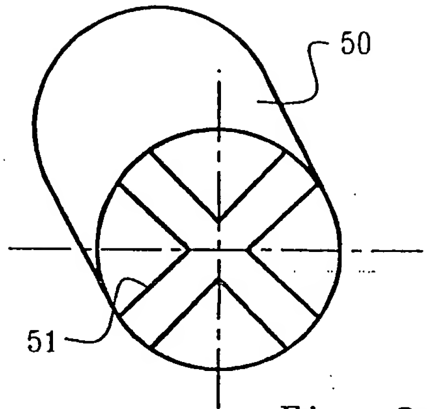

Fig. 3a

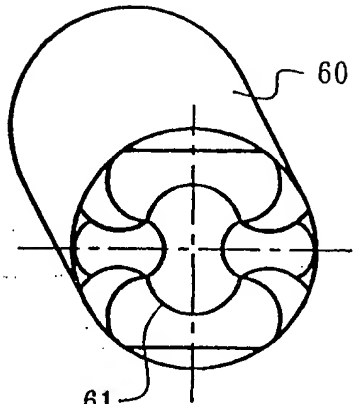

Fig. 3b

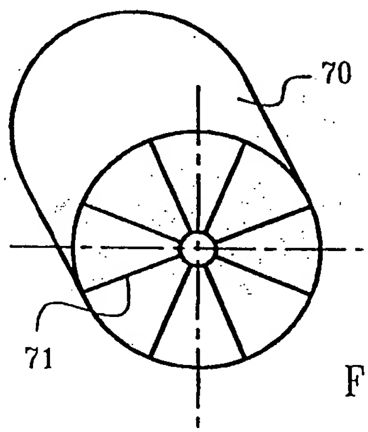

Fig. 3c

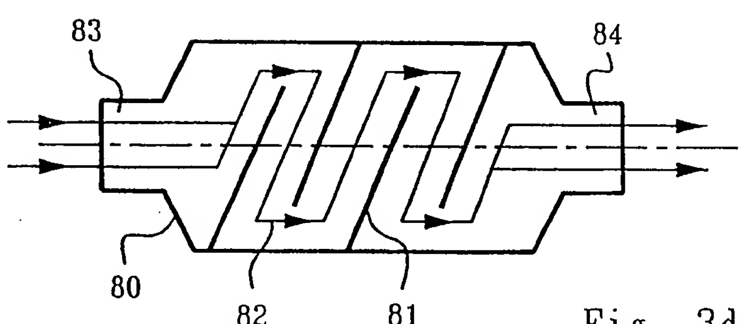

Fig. 3d

Nummer: DE 195 10 710 A1
Int. Cl.⁶: A 61 B 19/00
Offenlegungstag: 19. September 1996

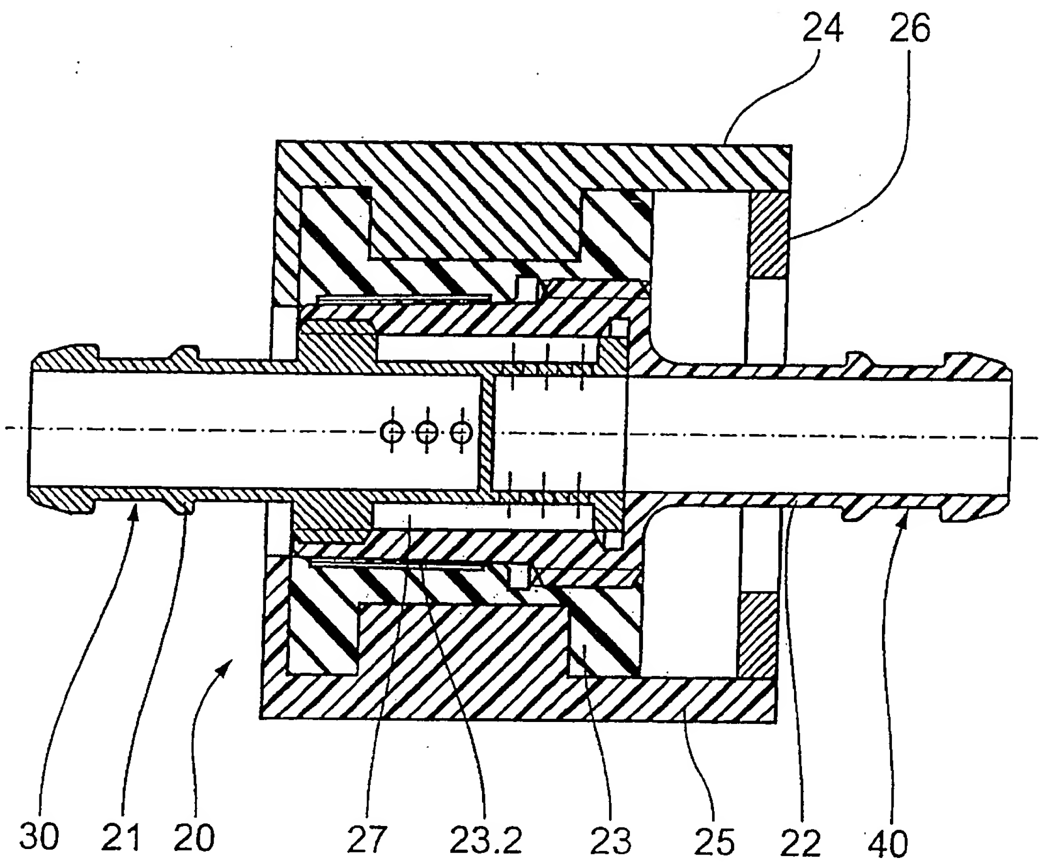

Fig.4

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Offenlegungstag: 19. September 1996

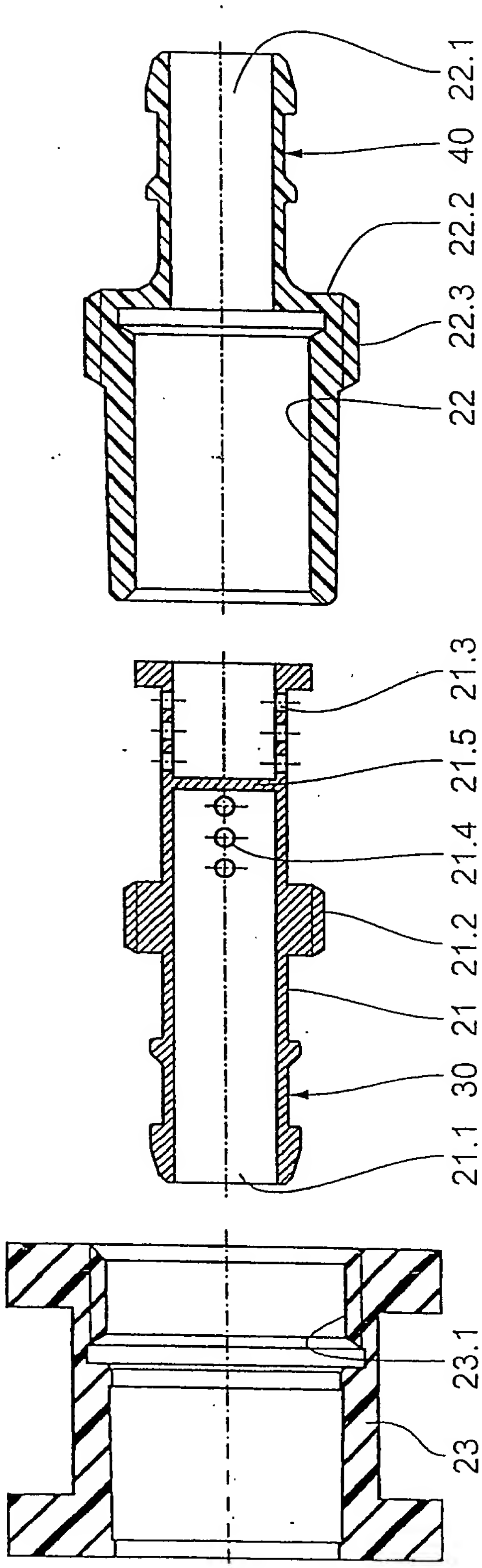

Fig.5c

Fig.5b

Fig.5a

Nummer: DE 195 10 710 A1
Int. Cl.^{6}: A 61 B 19/00
Offenlegungstag: 19. September 1996

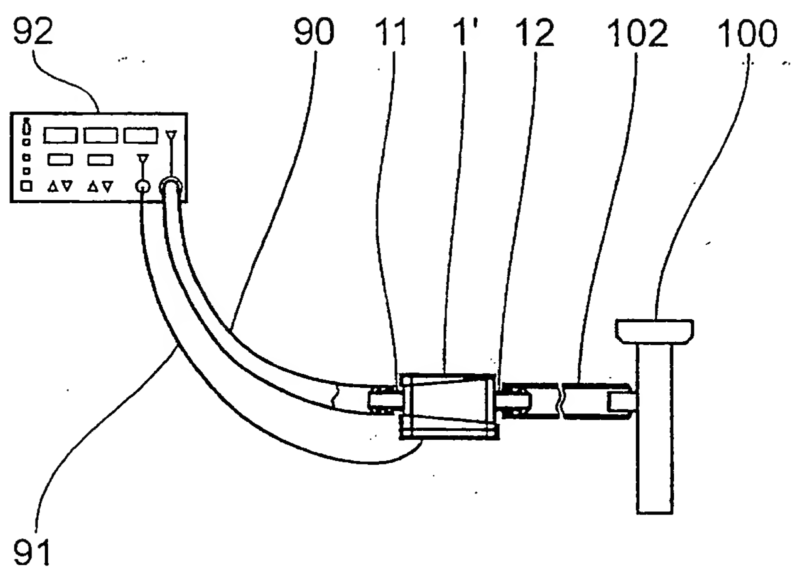

Fig.6